

## 寄生于褐家鼠的肉孢子虫一新种 (孢子纲, 真球虫目)

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**摘 要** 描述于云南省安宁市褐家鼠 *Rattus norvegicus* 肌肉内检获肉孢子虫 1 新种: 左氏肉孢子虫 *Sarcocystis zuoi* sp. nov.。新种肌肉内的包囊乳白色, 呈梭形, 大小为  $1\ 058\ \mu\text{m} \times 117\ \mu\text{m}$ 。包囊壁具有长指状突起, 突起大小为  $10.0\ \mu\text{m} \times 2.5\ \mu\text{m}$ 。透射电镜下, 包囊壁突起在基部高度分枝, 突起通过分枝的基部相互连接在一起。

**关键词** 孢子纲, 真球虫目, 肉孢子虫属, 新种, 褐家鼠。

中图分类号 Q959.115.6

鼠类肉孢子虫目前已命名 28 种, 中间宿主分布在啮齿目 2 科 23 属 78 种中, 终末宿主是猛禽、蛇和猫。鼠类肉孢子虫的研究主要集中在欧洲、澳洲和亚洲的东南亚地区, 国内并没有相关文献报道。作者对褐家鼠肉孢子虫的自然感染率进行了调查, 并在光镜和透射电镜详细观察比较其包囊形态学的基础上命名了 1 新种。该新种的模式标本和中间宿主的模式标本保存在云南大学生命科学学院动物标本室。

### 1 材料和方法

#### 1.1 肌肉镜检包囊

分部位剪取鼠肉, 剔除脂肪和结缔组织, 顺肌纤维方向将肌肉剪成铅笔芯粗细的小条, 有规则的置放在载玻片上, 每张玻片可放 5~10 条, 用另一张载玻片盖上, 轻压后, 低倍镜下检查肉孢子虫包囊。查到包囊后, 记下位置, 取去上面一张载玻片, 用解剖针将包囊剥离出来, 移入另一张载玻片上, 滴加 0.85% 的生理盐水, 加盖玻片, 高倍镜或油镜下观察包囊形态、测量和初步鉴定。刺破包囊可观察和测量溢出的缓殖子和母细胞。

#### 1.2 透射电镜材料制备

选包囊较多的一小块鼠肉, 以 2.5% 戊二醛 (0.1 mol/L pH=7.3 的磷酸缓冲液配制) 预固定 2 h, 1% 锇酸后固定 2 h, 经脱水包埋后做超薄切片, 以醋酸双氧铀和柠檬酸铅染色, 自然干燥, 透射电镜观察。

### 2 结果

在褐家鼠肌肉中发现 1 种肉孢子虫, 描述如下。

左氏肉孢子虫, 新种 *Sarcocystis zuoi* sp. nov. (图 1~4)

中间宿主: 褐家鼠 *Rattus norvegicus*。

终末宿主: 不明。

2002 年 1~12 月, 采集于云南省安宁市 (东经  $102^{\circ}35'$ , 北纬  $25^{\circ}24'$ ; 海拔 1 894 m)。采集地为稻田, 间有缓流水, 四周为低矮树木或灌木。

模式标本 含有肉孢子虫包囊的褐家鼠用福尔马林固定后保存于云南大学生命科学学院动物标本室。模式标本编号, R2002015-2002020。

自然感染率 采集剖检 112 只褐家鼠 (69 ♂, 43 ♀), 在 7 只鼠的肌肉中发现了肉孢子虫包囊, 自然感染率为 6.3%。分部位检查, 在食道肌、颈部肌、颌肌、舌肌、腹肌、膈肌、前腿肌、后腿肌、臀肌等 9 个部位都发现肉孢子虫包囊。心肌不被寄生。

包囊的形态学观察 光镜下包囊 (图 1) 乳白色, 长梭形, 大小为  $(2\ 325 \sim 700\ \mu\text{m}) \times (225 \sim 80\ \mu\text{m})$  ( $n=67$ ), 平均  $1\ 237\ \mu\text{m} \times 128\ \mu\text{m}$ 。有指状突起, 突起长 (含基质层)  $(12.5 \sim 7.5\ \mu\text{m}) \times (2.5 \sim 2.0\ \mu\text{m})$  ( $n=40$ ), 平均  $10.0\ \mu\text{m} \times 2.5\ \mu\text{m}$ 。缓殖子 (图 2) 香蕉形, 大小  $(10.0 \sim 7.0\ \mu\text{m}) \times (3.0 \sim 2.6\ \mu\text{m})$  ( $n=31$ ), 平均  $7.6\ \mu\text{m} \times 2.9\ \mu\text{m}$ 。包囊突起在透射电镜下呈稍微倾斜指状, 突起大小

云南省教育厅科研基金 (0141153) 和云南省自然科学基金 (2001C0002Q) 资助项目。

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收稿日期: 2004-10-26, 修订日期: 2004-12-11.

(不含基质层厚度) ( $12.5 \sim 9.2 \mu\text{m}$ )  $\times$  ( $3.1 \sim 2.0 \mu\text{m}$ ) ( $n = 32$ ), 平均  $10.5 \mu\text{m} \times 2.6 \mu\text{m}$ 。突起和基质层表面都有许多小凹陷。突起基部高度分枝, 各

个突起通过分枝的基部互相连接在一起, 突起内无微管, 突起和基质层内有许多颗粒状的致密电子颗粒。基质层厚  $0.4 \sim 0.6 \mu\text{m}$  (图 3、4)。

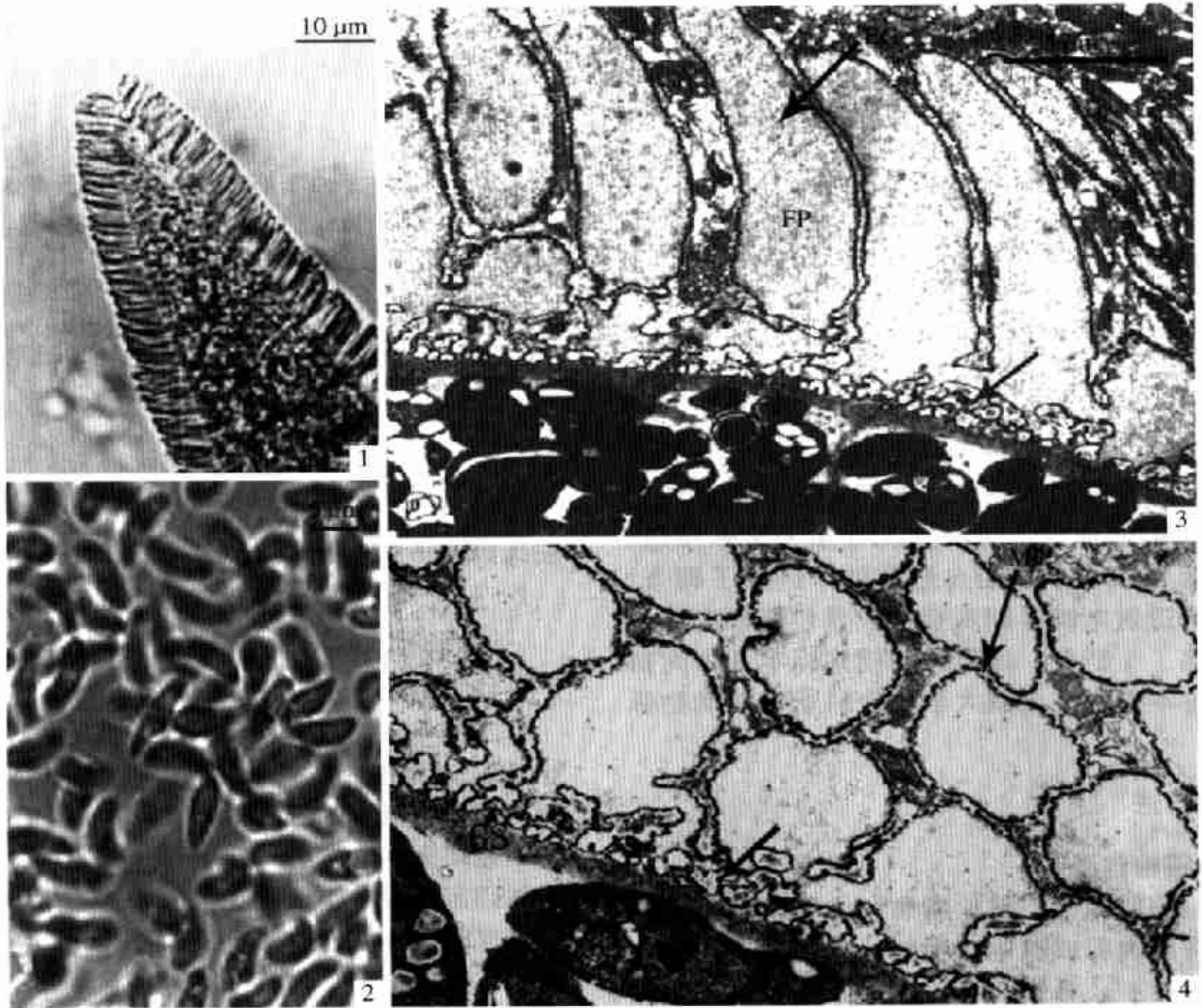


图 1~4 左氏肉孢子虫, 新种 *Sarcocystis zuoi* sp. nov.

1. 包囊壁上有长指状突起 (cyst surrounded by a cyst wall with long finger like protrusions) 2. 包囊里面香蕉形的缓殖子 (banana shaped zoites from cyst) 3. 包囊的纵切面, 指状突起 (FP) 表面有小凹陷, 突起内和基质层内有大量的致密电子颗粒 (EG), 突起基部高度分枝, 且各个突起通过分枝的基部互相连接在一起 (箭头) (Electron micrograph of a longitudinal section through the finger like protrusion (FP). Note that a highly branched primary sarcocyst wall at the base of the protrusions. The protrusions connect each other at the branched base (arrow). Over the surface of protrusions and primary cyst wall are minute invaginations. Within the protrusions and the ground substance there is a lot of electron dense granule (EG)) 4. 包囊的横切面, 示包囊壁突起表面的凹陷 (MI) 和高度分枝并互相连接的突起基部 (箭头) (Electron micrograph of a cross section through the finger like protrusions of the cyst. Note that the minute invaginations (MI) and highly branched primary sarcocyst wall at the base of the protrusions (arrow)) 标尺 (scale bars): 1=  $10 \mu\text{m}$ , 2~ 3=  $5 \mu\text{m}$ , 4=  $2 \mu\text{m}$

词源: 以云南大学生命科学学院左仰贤教授的姓氏命名, 以示对他在肉孢子虫和其它球虫生物学方面长期卓有成效工作的敬意。

### 3 讨论

迄今共报道了 6 种寄生于褐家鼠肌肉中的肉孢子虫: 西姆里肉孢子虫 *Sarcocystis cymruensis*、赞氏肉孢子虫 *S. zamani*、鼠虎蛇肉孢子虫 *S.*

*murinotechis*、新加坡肉孢子虫 *S. singaporensis*、绒毛状肉孢子虫 *S. villivilliosi*、和鼠猫肉孢子虫 *S. rodentifelis*。西姆里肉孢子虫光镜下包囊壁光滑, 电镜下包囊壁上有小瘤状突起, 电镜类型属于 1 型, 终末宿主为猫 *Felis cattus* (Ashford, 1978; Dubey *et al.*, 1989)。赞氏肉孢子虫的包囊光镜下包囊壁光滑, 电镜下包囊表面有不规则的小突起, 有时呈“T”形, 电镜类型属于 18 型; 绒毛状肉孢子虫包囊

有短指状突起, 电镜下突起形状呈圆柱状, 突起表面有齿轮状凸出, 有些凸出能够和基质层相连, 属于 22 型, 这 2 种肉孢子虫的终末宿主都是网斑蟒 *Python reticulatus* (Beave and Maleckar, 1981; Dubey *et al.*, 1989)。鼠虎蛇肉孢子虫的包囊在光镜下有指状突起, 电镜下突起呈墓碑状, 属于 15 型, 终末宿主是虎蛇 *Notechis ater* (Munday and Marson, 1980; Dubey *et al.*, 1989)。新加坡肉孢子虫, 同种异名东方肉孢子虫 *S. orientalis*, 包囊光镜下有指状突起, 电镜下突起呈棒状, 在靠近基质层的一端突然变细, 形成 1 个瓶颈, 属于 19 型, 终末宿

主是网斑蟒 (Zaman and Colley, 1975, 1976; Dubey *et al.*, 1989)。鼠猫肉孢子虫光镜形态和电镜形态与西姆里肉孢子虫一致, 实验感染表明, 该肉孢子虫既能在褐家鼠—猫之间完成其生活史, 也能在褐家鼠—褐家鼠之间完成其生活史 (Grikieniene *et al.*, 1993)。Odening (1998) 认为它可能是弓形虫 *Toxoplasma* 的同种异名。本次调查发现的左氏肉孢子虫的包囊有长指状突起, 电镜结构具有高度分枝的突起基部, 与其它已报道的肉孢子虫的形态显著不同。文献中关于褐家鼠的肉孢子虫的研究结果简要摘录见表 1。

表 1 已报道褐家鼠的肉孢子虫  
Table 1. Sarcocysts found in Rattus norvegicus .

| 种名<br>Species                         | 典型中间宿主<br>Type intermediate host | 包囊大小 (μm)<br>Cyst dimensions | 包囊壁形态<br>Cyst wall morphology |                   | 缓殖子大小<br>(μm)<br>Bradyzoite dimensions | 典型终末宿主<br>Type final host | 作者<br>Authors                    |
|---------------------------------------|----------------------------------|------------------------------|-------------------------------|-------------------|----------------------------------------|---------------------------|----------------------------------|
|                                       |                                  |                              | 光镜下形态<br>LM (μm)              | 电镜下类型<br>TEM type |                                        |                           |                                  |
| 新加坡肉孢子虫<br><i>S. singaporensis</i>    | 褐家鼠                              | 1 000× 120                   | 壁上有指状突起, 大小为 5.4× 1.5         | 19                | 6.0× 1.5                               | 网斑蟒                       | Zaman <i>et al.</i> , 1976       |
| 西姆里肉孢子虫<br><i>S. cymruensis</i>       | 褐家鼠                              | 30 000 ~ 50 000 (长)          | 壁光滑                           | 1                 | -                                      | 猫                         | Ashford, 1978                    |
| 鼠虎蛇肉孢子虫<br><i>S. murinotæhis</i>      | 褐家鼠                              | 300× (90~ 60)                | 壁上有舌状突起, 大小为 6× 4             | 15                | -                                      | 虎蛇                        | Munday <i>et al.</i> , 1980      |
| 绒毛状肉孢子虫<br><i>S. villivillosi</i>     | 褐家鼠                              | 1 000× 100                   | 壁上有短指状突起, 大小为 1.6 × 0.5       | 22                | 5× 1                                   | 网斑蟒                       | Beaver <i>et al.</i> , 1981      |
| 赞氏肉孢子虫<br><i>S. zamani</i>            | 褐家鼠                              | (2 000~ 1 000) × 500~ 300    | 壁光滑                           | 18                | 8~ 7× (1.5~ 1.0)                       | 网斑蟒                       | Beaver <i>et al.</i> , 1981      |
| 鼠猫肉孢子虫?<br><i>S. rodentifelis</i>     | 褐家鼠                              | -                            | 壁光滑                           | 1                 | -                                      | 猫                         | Grikieniene <i>et al.</i> , 1993 |
| 左氏肉孢子虫, 新种<br><i>S. zuoi</i> sp. nov. | 褐家鼠                              | 2 325~ (700× 22) 5~ 80       | 壁上有指状突起, 大小为 10.0× 2.5        | 17                | 7.6× 2.9                               | -                         | 本次实验<br>This study 2003          |

“-” 表示未做此观察, “?” 表示对此种存在疑问.

家畜肉孢子虫对中间宿主具有种的宿主特异性, 但在野生小型兽类尤其是鼠类的肉孢子虫研究中, 这种观点受到了强烈的挑战。Häfner 等 (1984) 的实验感染研究中发现绒毛状肉孢子虫的中间宿主包括鼠属 *Rattus* 和板齿属 *Bandicota* 11 种鼠类, 新加坡肉孢子虫的中间宿主包括鼠属和板齿属 11 种鼠类。这种现象在野外调查中得到了进一步证实, Jäkel 等 (1997) 在泰国野生的褐家鼠、黑家鼠 *R. rattus*、米田鼠 *R. argentiventer* 和印度板齿鼠 *B. india* 的肌肉中发现了新加坡肉孢子虫, 在马来西亚

田鼠 *R. tiomanicus* 的肌肉中发现了绒毛状肉孢子虫。  
建立在表型基础上的肉孢子虫的分类标准主要包括: (1) 包囊的形态结构; (2) 生活史。包囊的形态结构最具有分类学价值的是包囊壁的超微结构, 特别是包囊壁突起的超微结构 (Tenter *et al.*, 2002)。尽管肉孢子虫的生活史在肉孢子虫的分类方面有非常重要的意义, 但由于生活史的完成是件费事、费力、花费较大的工作, 同时, 由于一种中间宿主和终末宿主可以被多种肉孢子虫寄生, 某些实

验结果容易引起争议。在目前已命名的 189 种肉孢子虫种中, 只有 86 种肉孢子虫的中间宿主和终末宿主都被研究清楚 (Odening, 1998)。本次研究用左氏肉孢子虫实验感染猫, 结果为阴性。生活史的完成需要进一步研究。

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## A NEW SPECIES OF SARCOCYSTS (SPOROZOA, EUCCOCCIDIIDA) FROM RATTUS NORVEGICUS

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**Abstract** The paper deals with a new species of sarcocysts from wild caught *Rattus norvegicus* collected in Anning district, Yunnan Province, China. Measurements are in microns and were based on 7 specimens. Type specimens are deposited in the School of Life Science of Yunnan University in China.

*Sarcocystis zuoi* sp. nov. (Figs. 1-4)

Intermediate host. *Rattus norvegicus*. Final host.

Unknown. Infection rate: 6.3% (7/112).

Locality. Anning District (25°24'N, 102°35'E; 1894 m), Yunnan Province, China.

Cysts. The spindle shaped cysts in skeletal muscle (but not cardiac muscle) measured 1 058  $\mu\text{m}$   $\times$  117  $\mu\text{m}$ . Cyst wall thick, striated with villi up to 10.0  $\mu\text{m}$   $\times$  2.5  $\mu\text{m}$ . Ultrastructures revealed that there was highly branched primary wall at the base of the protrusions. The protrusions connect each other at the branched base. There are minute invaginations over the surface of protrusions and primary cyst wall. Within the protrusions and the ground substance there is a lot of electron dense granules, none of which contains fibrils.

Zoites. Small, banana shaped, up to 7.6  $\mu\text{m}$   $\times$  2.9  $\mu\text{m}$ .

Type specimens. Formalin fixed tissues containing cysts deposited with Zoological Specimen Room of School of Life Science of Yunnan University in China (accession Nos. R 2002015-2002020).

**Key words** Sporozoa, Eucoccidiida, *Sarcocystis*, *Rattus norvegicus*, new species.

**Etymology.** The specific epithet *zuoi* is derived from ZUO Yang-Xiang, one of highly effective explorers in sarcocyst research field in China.

Six *Sarcocystis* species had been reported from *Rattus norvegicus*. At the light microscopical level, the six sarcocysts could be further characterized as those with a radiantly striated or smooth cyst wall. *Sarcocystis singaporensis*, *S. villivill* and *S. murinotachis* cysts possessed striated walls with a dimensions 5.4  $\mu\text{m}$   $\times$  1.5  $\mu\text{m}$ , 1.6  $\mu\text{m}$   $\times$  0.5  $\mu\text{m}$  and 6  $\mu\text{m}$   $\times$  4  $\mu\text{m}$ , respectively. In *S. singaporensis*, a distinctive feature is the thick cyst wall with its large, stalked villi. Here, stalks and protrusions formed two distinct longitudinal layers. In *S. villivill*, electron micrographs of cysts showed that the villi extend from the surface of the cyst, with bottleneck-shaped, radiating microvilli that extended outwardly at varying intervals from the surface of the vill. Some of the microvilli appeared to form connections with the primary wall. In *S. murinotachis*, the cysts had short, broad protrusions with many invaginations but without necks. In *S. zuoi*, the cysts had long, finger-like protrusions, highly branched at the base of cyst wall. The protrusions connected each other at the branched base. This was a marked difference to among the other species where the highly branched cyst wall was not present.